§6. Radiation Profile Measurements for Edge Transport Barrier Discharges in the Compact Helical System Using AXUV Photodiode Arrays

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The formation of the edge transport barrier (ETB) has recently been found in the Compact Helical System (CHS) plasmas heated by co-injected neutral beam injection (NBI) with strong gas puffing.[1] The ETB mode is characterized by the rapid increase in the electron density near the edge following the abrupt drop of hydrogen Balmer alpha (H_α) line intensity. Recently the absolute extreme ultraviolet (AXUV) photodiode which has near theoretical quantum efficiency for a wide range of photon energies are used for bolometric measurements in fusion plasma experiments. In addition to single channel pyroelectric detector as a conventional bolometer, we have employed the AXUV photodiode arrays as a simple and low-cost diagnostic to investigate spatial and temporal variations of radiation emissivity in the CHS plasmas with ETB. A compact mounting module for a 20 channel AXUV photodiode array including an in-vacuum preamplifier has successfully been designed and fabricated.[2] Two identical modules were installed in the upper and lower viewports within the horizontally elongated cross section of the CHS plasma. Lines of sight of the detector arrays and magnetic flux surfaces (R_{ax}=92.1 cm, 0% quadrupole component) are illustrated in Fig. 1. The 12 channels out of 40 are available for simultaneous measurements at present due to the limitation of the data acquisition system.

Figure 2 displays the result of the measurement in a typical ETB discharge for the configuration shown in Fig. 1. The transition to the ETB mode occurred at t =76 ms. The AXUV photodiode signals for channel numbers 2 (near the edge) and 6 (through the center) are shown in the lower figure together with the H_α signal. It has been confirmed that the signals of AXUV photodiode and pyroelectric detector in the ETB discharges show roughly the same behavior except for the very beginning and end of the discharges. The signals of all the channels of the AXUV photodiode arrays begin to increase more rapidly at the moment of the transition than before. The rate of the increase is larger for the edge viewing chord (ch2) than for the center viewing one (ch6), which indicates the flattening of the radiation profile following the change in the electron density and impurity profiles after the formation of the ETB. However, the signals for the edge chords tend to saturate after several tens of milliseconds, while they still continue to increase for the central chords until the back transition, which results in the peaking of the radiation profile near the plasma center. Although an accumulation of impurity ions near the plasma center is assumed, the details should be investigated based on the electron density and temperature profiles measured by Thomson scattering diagnostic.

References

1) Okamura, S. et al.: Plasma Phys. Control. Fusion **46** (2004) A113.

2) Suzuki, C., Peterson, B. J., Ida, K: Rev. Sci. Instrum. **75** (2004) 4142.

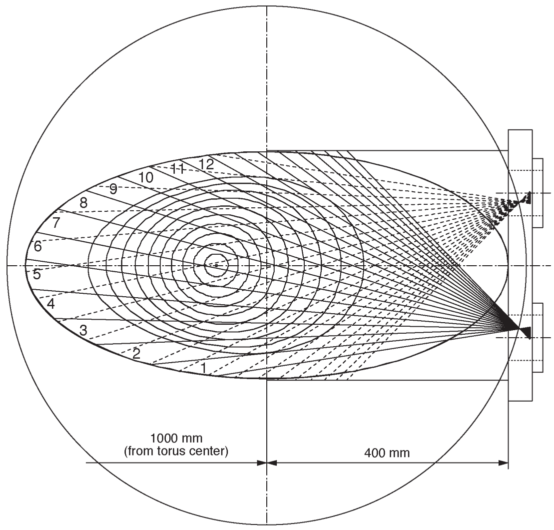

Fig. 1. Lines of sight of 20 ch AXUV photodiode arrays and magnetic flux surfaces (R_{ax}=92.1 cm, 0% quadrupole component). The 12 channels can be simultaneously measured at present.

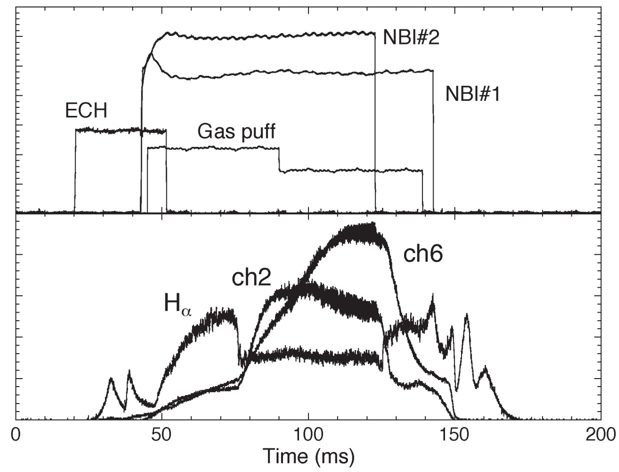

Fig. 2. The temporal variations of heating, gas puff, H_α signal and AXUV photodiode signals for channel numbers 2 (near the edge) and 6 (through the center) in a typical ETB discharge.